Testing of Low-Profile Composite Dome Under Internal Pressure

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Low-profile domes are becoming more and more important in aerospace design as a means of reducing overall vehicle weight and increasing the volume of a tank for a given length. Most low-profile dome designs considered thus far have been metallic. Since composite materials offer significant performance and weight advantages over metals, a Center Director's Discretionary Fund (CDDF) project was initiated to apply composites to the low-profile dome concept.

The purpose of this project was to design, manufacture and test a low-profile composite dome with a radius-to-height ratio of three using graphite-epoxy material. Design and analysis was performed using several computer programs for determining ply layups and finite element analysis to verify the design and generate test predictions. Computational methods and spreadsheets were also used to determine the ply layup sequence and to give technicians the proper geometries of each ply. The dome was successfully manufactured in the MSFC Productivity Enhancement Complex (PEC) via hand layup using a toughened resin graphite-epoxy material.

The test will consist of a sequence of internal pressure loadings that will measure the strain and displacement response of the dome as a function of pressure. At least three potential failure modes exist: Circumferential buckling, biaxial tension and biaxial tension-compression. Valuable data as to which of these modes causes first failure will be obtained, along with data from modern inspection methods such as acoustic emission, video image correlation and laser shearography.

The data obtained from this effort will provide a valuable technology that will greatly assist designers of future aerospace vehicles such as the Reusable Launch Vehicle, future expendable launch vehicles, upper stages, reusable orbital transfer vehicles and future exploration vehicles. Data from this study will also be of use in other applications since it characterizes the behavior of composites under a variety of stress states.

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University/Industry Involvement: NASA Academy Summer Intern Program

Biographical Sketch: Rafiq Ahmed is a structural analyst and has performed stress analysis on space shuttle and advanced technology hardware.